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TECHNICAL EDUCATION AT THE POLYTECHNIC INSTITUTE, BROOKLYN

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President.

On every hand is to be found abundant evidence that there is a remarkable public interest in industrial education. This interest is not perfunctory and limited, but widespread and profound. Discussions of this question are reported and criticised in the press as well as from the pulpit and the platform. When the National Society for the Promotion of Industrial Education was organized, among the charter members were public school teachers, college presidents and professors, editors, preachers, judges, manufacturers, bank presidents, wage earners, social workers and others. This great public interest in industrial education as a social and economic force cannot but have a marked influence, not only on the public school system, but on the one hundred and thirty-five departments and schools of technology which exist at present in this country. One of the most valuable results in the movement for industrial education will be the necessity of broadening the test to be applied to every grade of education from the kindergarten to the university. Practical utility as well as the general development of mind and character must be made the test of education. Economic efficiency as well as mental training must be the goal of all our educational workers. This is an economic age, and it is well that education has become an economic question in a sense never so true before.

The Polytechnic Institute of Brooklyn is doing on a small scale, I believe in an effective manner, what institutions like the Massachusetts Institute of Technology and Sibley College are accomplishing so well on a considerably larger scale. Half a century ago, when it offered its first course in civil engineering, there were but six institutions in America providing such a course. Therefore, the Polytechnic may be regarded as a pioneer in the field of engineering education.

Its history as a college is significant in its bearing upon the changes which have taken place during the same period in the

social and industrial conditions of our larger commercial cities. Its curriculum at first, when there were no public high schools, mainly preparatory for college, was enlarged to include two courses of study leading to the degrees of bachelor of science and the bachelor of arts. Later, as a result of its industrial environment, the Polytechnic resolved its science course into courses of applied science, leading to the degrees of civil engineer, electrical engineer, mechanical engineer and bachelor of science in chemistry. In 1893, the number of students in the course in arts and those in the courses of applied science were equally divided. Last year (1907) the number of regular students in the technical courses was eleven times that in arts. The arts course has now been discontinued, and in response to a compelling demand the distinct and definite function of the institute has become the training of men to undertake professional responsibility in the departments of chemistry and engineering. In addition to its regular day courses, the Polytechnic provides parallel courses given in the late afternoons and evenings. Such "extension" courses present to those who are otherwise engaged during the day opportunities for securing thorough and systematic instruction in engineering and chemistry.

Location has determined very materially the development of its courses. Fully fifty per cent of its students are admitted from the high schools of Greater New York, which are among the best in the country. With the greatly increased effectiveness of science instruction and instruction in mathematics and English in our secondary schools in recent years and the introduction of manual training in some form as an integral part of the course of study of both the elementary and secondary schools the conditions for entrance have become unusually high. Recommendations of a student's fitness are always investigated, and this is easily done under the circumstances. The tuition is considerably higher than that demanded by the New York University. It is the desire of the supporters of the Polytechnic that it shall remain a small school which shall make primarily for the highest efficiency, and thus great care is taken in selecting the material. The large city furnishes well-prepared and mature students, although such applicants are apt to average a year older than in most technical schools. The average age of the present entering class is a little over twenty years. This has a very important bearing on the character and duration of the course which

should be given to them. It may be heresy, but I cannot personally advise such men first to take a full college course and then the technical course, but rather the ideal is a five or better, a six years' combined college and technical course.

Metropolitan advantages are an invaluable asset. I might almost say are an absolute necessity to any engineering school. The unparalleled range of engineering practice afforded by New York is not merely an inspiration, but a valuable part of the student's subject matter.

The Polytechnic numbers at present a little less than two hundred students in the regular day courses, and it is the intention of the authorities not to exceed two hundred and fifty. A system of small classes admits of an unusually high grade of work, impossible where great numbers are grouped and submitted to the same educational process. Instruction in the more advanced classes is almost individual. This insures thoroughness, the correction of individual weaknesses and the development of men of power. The rate of advancement under such conditions becomes largely an individual matter. While the courses are mapped out for four years, yet the number taking five years to complete the work is increasing. In a small school, I believe it will be ultimately possible to make the length of the undergraduate course indeterminate. This is true of the course in architecture at the Beaux Arts, Paris, and in a certain sense of the courses offered by the German universities. The satisfaction of formal examinations should not alone determine the candidates' fitness for graduation, but the degree of practical efficiency shown in laboratory and field should be considered.

One peculiarity of our present educational progress lies in the rapid strengthening of the present technical courses. The professional training now needed is in marked contrast to that offered twenty years ago. The industrial world is becoming more complex, more complicated, more confusing. Enormous industries have developed which require a degree of skill, intelligence and knowledge, and a high order of executive ability, which were entirely unnecessary in the day of smaller concerns. The demand for trained leaders has thus rapidly increased. Meantime, the whole problem of higher technical education has changed; technical education, while retaining its form, has broadened. "To-day the school of technology," to quote President Pritchett, "is called upon, not

for a new form of education, but for an adaptation of its curriculum in such measure as to serve the needs of the man and of the engineer." No one questions the value of a thorough technical training, but many do regret that the graduates of colleges of technology are often deficient both in general culture and in those social qualities that make for the highest success. In my judgment, one of the important problems of engineering education to-day is how to give the students a wider culture and how to provide them opportunities for the development of those higher social qualities that make for leadership.

A careful study of the catalogues of a large number of technical institutions and visits to certain representative schools throughout the country show that there is considerable diversity in the courses offered in technology. The last twenty years has witnessed a generous expansion of our technical courses. They are now characterized by greater breadth and variety; and the tendency on every hand is to insist more strongly than heretofore upon culture studies as essential to the engineer and the chemist. A number of technical institutions require that these be obtained before entrance. Fortunately there has been a decided improvement in secondary education in all parts of the country since that celebrated report of the committee of ten appeared more than ten years ago. This advance in the engineering student's previous preparation has undoubtedly tended to lessen somewhat the burden of the higher institution. For instance, it is becoming more and more possible, with the certainty that the instruction will be well done, for the Polytechnic to require that trigonometry and general chemistry be offered for admission. This permits the introduction of qualitative analysis in the freshman year and cuts down the time to be spent in mathematical study. Instruction in the modern languages is being more efficiently performed, and the next cut will come, I believe, in this department. Moreover, promoters of engineering education are beginning to question the relative culture and technical value of extended courses in modern language instruction for the engineer.

The curriculum of the Polytechnic includes, very roughly stated, fifty per cent of strictly technical studies, thirty per cent of studies indirectly technical, as sciences and mathematics, and twenty per cent of culture studies. As a result of its traditions as a college of arts, which it was until recently, as well as a college of engi-

neering, the Polytechnic has always placed great emphasis on the importance of liberalizing study for the engineer and chemist. Like all professional men, engineers should have the broadest outlook, the largest view of men and things. In this belief, the Polytechnic is including in its engineering curriculum this year for the first time brief courses in philosophy, logic and psychology. In adding these subjects to the usual culture studies of English, history, economics and the modern languages, it is attempting, with what success it remains to be determined, to give a breadth of culture that few engineering schools are providing to-day.

The attempt to give a more general cultivation is not at the expense of the theoretical instruction in the mathematical, mechanical and scientific principles, which are the core of every efficient engineering course. Quite the contrary. Greater and greater provision has been made for special as well as for general knowledge. In a certain sense the courses have become more theoretical and less practical. It has been found desirable and possible to reduce the time given to the workshop and the draughting room. An increasingly large number of students are having opportunities for good courses in mechanical drawing and manual training before admission. Situated as the institute is in New York, the students are able usually to secure positions for the long summer vacations, which furnish them with an experience of a practical kind. During the school year there are those who are obliged to earn part of their expenses; these young men have no difficulty in finding occupations more or less closely related to their chosen profession. The majority of the graduates remain in New York and secure positions of responsibility in the municipal departments or in the larger industrial firms. The fundamental requisite of an engineering education which would fit men for executive positions is general culture. Its fundamental characteristic is a thorough training in the theory of engineering operations based on the principles of mathematics and science.

To give this fundamental scholarly training in principles in an illustrative and thorough manner is the chief end of the technical school. However, for technical work knowledge alone is not sufficient without the ability to apply it in any given case. Practice alone leads to a complete conception of truth; it is the higher step of knowledge, of which general scientific knowledge is the first step.

The details of practice can only be taught by experts, and colleges of engineering may appoint a certain number of eminent specialists as consulting professors. Only successful practitioners can present the complex problems of actual practice. From the beginning, the difficulties and conditions of actual service and the application of theory to practice must be made plain to the student. An attempt has been made in the Polytechnic Institute to bridge the gap between professional study and practice by supplementing the work of the regular instructors by lectures, conferences and demonstrations by consulting professors who understand the manifold conditions of actual practice. In this age of continual change and progress, the regular professors cannot be expected to keep closely in touch with all the advances made. These collaborators who have been brought in from the industrial world bring to the teaching and the student body the latest advances in mechanical manipulation and in the application of scientific principles to industry.

The plan of supplementing the regular instruction in a most practical way has worked so successfully in connection with the subjects strictly technical that a broader application of the principle is to be made this year. The regular instruction in our course in municipal government is to be supplemented by a series of twelve lectures to be given by the specialist of the Bureau of Municipal Research upon the actual workings of each of the municipal departments of Greater New York. I have noted with interest that this principle is to be applied extensively in connection with the business course which Harvard University has just opened.

The Polytechnic fails, as does every technical school which does not aim to give to the student a capacity for work, a faculty to do other work of like character, broader intellectual horizons, purer ideas of life, greater confidence in his intellect, and a keener appreciation of his moral obligations.

In order that the Polytechnic Institute may benefit not only the favored few who are able to pursue the regular day courses, but the worthy many and that its equipment of men and machines may do the largest good, it throws open all its facilities in a parallel series of afternoon and evening classes to intelligent and ambitious mechanics and practicing engineers who feel the need of higher study. The Polytechnic has achieved considerable success during the past four years in the service performed by it in this direction. Experi-

ence has demonstrated that these parallel classes can be conducted upon a high level without detriment to the quality of the regular courses. These courses are especially designed to afford men in actual practice opportunities for professional study. There are already this year over three hundred registrations. There are fifty degree-holding students of other institutions who are working for Polytechnic degrees and in addition many others who have partially completed the prescribed courses of technical degree granting schools. This year instruction in forty-four different subjects is offered. The largest enrolment is in the civil engineering subjects. There are fifty-five in water supply, which is given by a prominent New York sanitary engineer, who has been appointed consulting professor; fifty-four in elementary survey; thirty-one in railway curves and earthwork; thirty-eight in theory of structures, and twenty-two in bridge and structural design. In the mechanical engineering department there are twenty-three in steam engineering; twenty in works engineering, and twenty-three in experimental engineering. In the department of physics and electrical engineering the courses are filled to the limit of equipment and efficiency. It is significant that more and more students are entering with the intention of completing the full course for the degree.

These evening technical courses supplement, especially in theory, the work done at Pratt Institute in the applied electricity and steam and machine design courses. Graduates of the engineering courses of Cooper Union, of whom the greater number entering wish civil engineering, desire the work in order to complete their knowledge of survey, structures, bridge design and higher mathematics. As no work in English, modern languages, history and economics is given at Cooper Union, courses in these subjects are well attended. In an enrolment of twenty-two in the course in English composition there are a large proportion of men actually engaged during the day in engineering and chemistry.

The average age of those enrolled in this evening department is twenty-five. It is of interest to note that men from the municipal departments of the five boroughs constitute a good part of the enrolment. Students are drawn from the departments of water, gas and electricity, topographical bureaus, department of water supply, the new public service commission; students from the technical forces of the Brooklyn Rapid Transit and the Interborough Rapid Transit companies, and the larger chemical works.

In many respects this evening work in higher technical education is unique; it is certainly important. It represents the complete utilization of an educational plant. It furnishes an educational opportunity to a rare lot of mature men who know what they want and how to profit by it.